OFFICIAL JOURNAL OF
THE MUSHROOM GROWERS'
ASSOCIATION

MGA

BULLETIN

MARCH, 1953 · NUMBER 39

CONTENTS

	Page
Editorial : Skal !	67
Stanley Middlebrook's Diary	69
My Way of Growing : 9—Harald Stridsberg (Sweden)	71
Progress in French Research : R. L. E.	74
Another Heating System : F. R. Frampton	75
My Favourite Recipes : 3—Mrs. George W. Baker	77
TRACE ELEMENTS FOR MUSHROOM CULTURE : Dr. B. B. Stoller	78
Research in Sweden	85
Open Day and Refresher Course	85
Research Annual Meeting	87
Conference in Belgium	87
Dr. Edwards in Worthing	89
Stanzas to Stanley : M. C. Luxmoore	89
Seen This ?	91
Items of Interest	91
New Members	91

5/-

COMMONWEALTH MYCOLOGICAL INSTITUTE
2 MAR 1953

SALUTE TO SWEDEN

"THE FLOWERS THAT BLOOM IN THE SPRING, TRA LA,
HAVE NOTHING TO DO WITH THE CASE,
YOU'RE GOING TO BROOME & GREEN, TRA LA,
NO FLOWERS CAN ADD TO YOUR GRACE"

All the Best mushrooms
go to the LARGEST DISTRIBUTORS
IN THE UNITED KINGDOM —

BROOME & GREEN (London) LTD.
COVENT GARDEN MARKET, LONDON

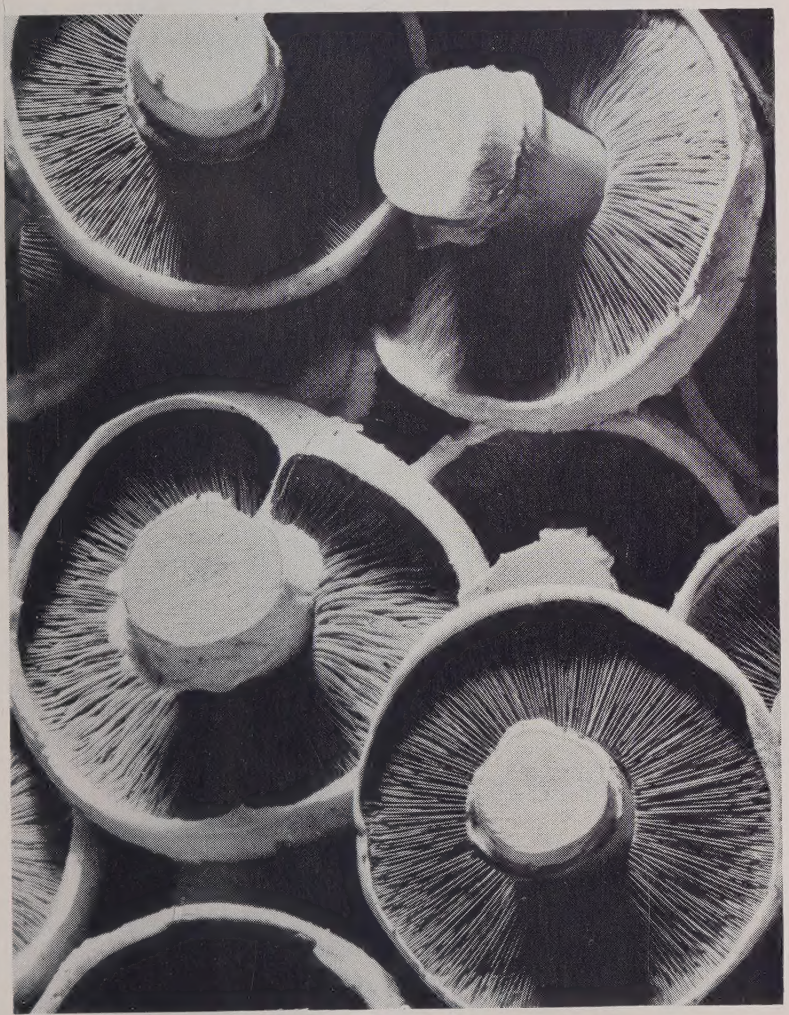
BROOME & GREEN (Glasgow) LTD.
CANDLERIGGS MARKET, GLASGOW

SOMERS & GIBSON LTD.
MANCHESTER & BLACKBURN

REGISTERED B&G TRADE MARK

YOU can be Sure of

Mount Mushroom Spawn



Distributors: **J. E. R. SIMONS LTD., HARLOW, Essex**

TELEPHONE: POTTER STREET 65

Typical Retailers WE serve with YOUR produce

*The name, of course, does not refer to any specific person.

CLIVE GRAHAM *

the owner of a high class fruiterers and florists business within the city.

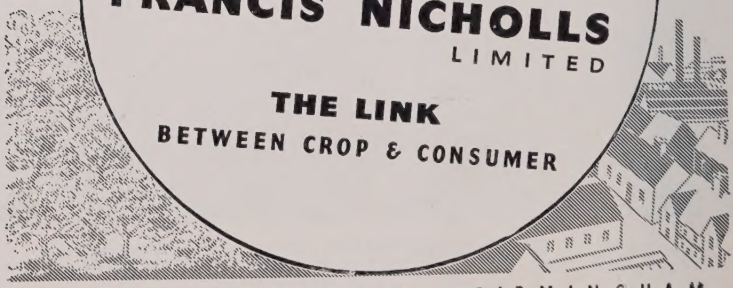
"I have taken over the family business after a good training under my father. It is essential for me to have a wide variety of everything in season, and it must be of the very best — whether it be Pineapples, Tomatoes, Mushrooms, Choice Grapes or again say Roses, Carnations or the Orchids for a wedding. Dad always said that only the best was good enough for him. Well . . . I've tried everywhere, but I *still* find the best selection at Francis Nicholls Ltd."

Like father like son.

RETAIL BUYERS WHO TAKE A PRIDE IN THE GOODS THEY OFFER TO THE PUBLIC WILL ALWAYS GIVE PREFERENCE TO THE PRODUCER WHO TAKES A PRIDE IN THE QUALITY, GRADING AND PACKING OF HIS PRODUCE

FRANCIS NICHOLLS
LIMITED

THE LINK
BETWEEN CROP & CONSUMER



SMITHFIELD MARKET • BIRMINGHAM

Mushrooms galore in KING
precast concrete MUSHROOM HOUSES

HIGH INSULATION

The insulation value of the 4 inch thick Foamed Slag Block wall (unrendered) is higher than that of an 11 inch cavity brick wall rendered and properly ventilated.

LOW COST

The strong concrete frame makes a load-bearing wall unnecessary; the 4 inch Foamed Slag Block wall keeps heat in and costs down.

EASY ERECTION

This has been a major aim, and it has been achieved. A local builder can do the job with no trouble at all.

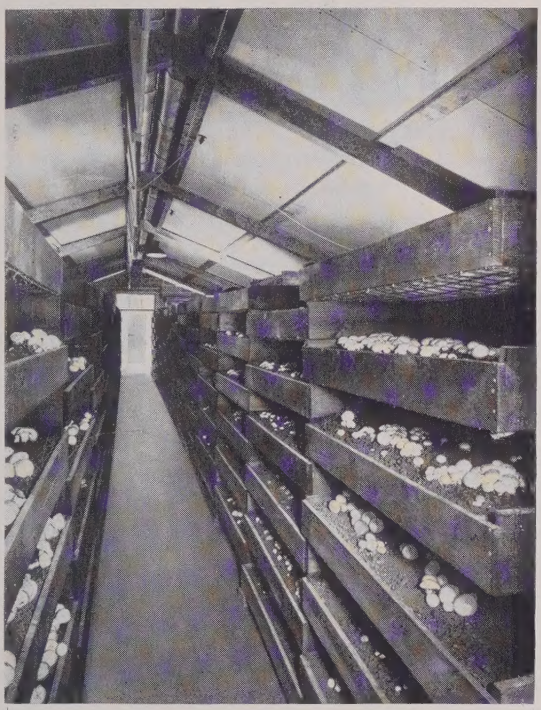
WIDTH: 18 ft.

LENGTH: In multiples of 10 ft.

HEIGHT: 6 ft. 6 ins. to 8 ft. at eaves.

BENCH OR TRAY: The houses are equally suitable for either system.

CAPACITY: An 18 ft. by 60 ft. house will hold over 500 (4 ft. by 2 ft.) trays.



Inside a typical KING Prefabricated Mushroom House, one of a number designed, manufactured and erected by Geo. W. King Ltd. for Dr. A. R. Rooke, Alton, Hants.

Write for fuller details to W. DARLINGTON & SONS LTD.
WORTHING, SUSSEX, *Sole Agents for* KING *Mushroom Houses in the British Isles*

KING

PRECAST CONCRETE MUSHROOM HOUSES

REGISTERED TRADE MARK

PERFECT MANURE TURNING

100% AERATION 100% TEASING

No. 6

DLP COMPOSTER

PATENT No. 627955 ETC.

ATTACHMENT FOR AUTOMATIC WATER SPRINKLING

— IN USE ALL OVER BRITISH ISLES AND ON CONTINENT —

ALSO SOIL BREAKERS AND SPECIAL MACHINERY
DESIGNED & MADE FOR NOBLE MUSHROOMS LTD., OF YAXLEY

INQUIRIES TO:

HARRY F. ATKINS (Machine Tools) Ltd.

OLD FLETTON, PETERBOROUGH

'Grams: "ATKINS, OLD FLETTON" Tel.: Peterborough 2852

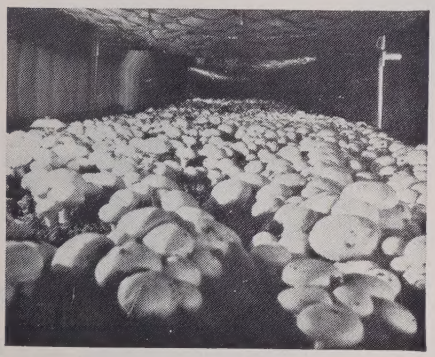
BIGGEST SUPPLIERS IN ENGLAND

Stable Manure or Wheat Straw

FOR THE

MUSHROOM GROWER

ROAD OR RAIL TO ANY DISTRICT IN ENGLAND



A good crop of Mushrooms grown by a Sussex customer on Stable Manure supplied by us.

We also supply Cow and Pig Manure for the Market Gardener.

★

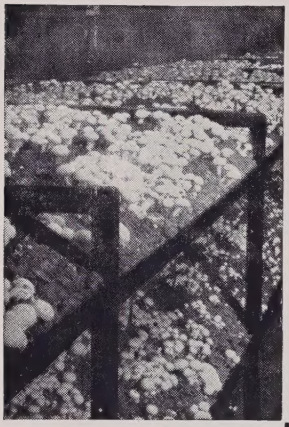
D. C. BUSHELL & CO.

(EASTERN) LTD.

AGRICULTURAL MERCHANTS

SANDHURST MILLS, CAMBERLEY, SURREY

Telephone : YATELEY 2241 (4 lines)

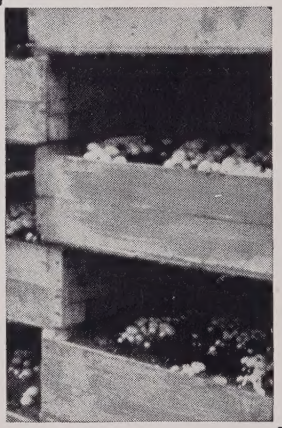


For Finest Crops

from Shelves . . . .

from Trays . . . .

from Beds . . . .



DARLINGTON'S

100%

PURE CULTURE

SPAWN

WHETHER you favour the shelf, tray or flat-bed system of Mushroom Culture, you will find that the heaviest crops result from the use of 100% Spawn. And, because of our exclusive technique employed for spore selection and propagation, crops are consistently of the highest possible quality—outstanding in flavour, size and colour.

It pays to use Darlington's 100% Spawn.

Our Advisory Department will be pleased to give information or guidance on Mushroom Growing to any Commercial Grower.

W. DARLINGTON & SONS LTD.

Mushroom Spawn and Insecticide Specialists

WORTHING SUSSEX

The
MGA BULLETIN

MARCH 1953
NUMBER 39

EDITORIAL:

SKAL! *—If that's how you spell it!*

Nearly 30 degrees of frost, and no trousers! Early in February several overseas grower-members of the MGA observed your Editor in this formidable Fahrenheit context. Fortunately the frost was outside, and he was inside, crouched over a multi-barred electric fire.

It was in Sweden. With Mr. Guy de Man of Brussels (whom I keep meeting in the most unlikely places), Mr. Gunnar Westin and Mr. A. Wiberg, I had motored up from Gothenburg to see the mushroom trays in the caves at Kinne Kleva, and after 100 miles of icy roads we had been forced by snowdrifts to stop and walk the remaining 300 yards. The snow was 3 ft. deep for no more than 30 of these yards, and stupidly I ignored advice and took a short cut! It was long enough to wet my trousers through and to chill me so thoroughly that, in the steel grip of a piercing wind, I would certainly have collapsed had not Mr. Westin come to rescue me.

The other two had reached the shelter of the caves some minutes earlier and were sitting round the office fire. They also were bitterly cold, and seeing me stagger in and promptly remove my trousers struck them as irresistably funny. A moment later they realised my predicament and scalding coffee from Mr. de Man and brisk massage from Mr. Wiberg soon revived me. In ten minutes I was not exactly laughing, but able to appreciate the humour of it—in an abstract sort of way.

This was the only unhappy moment in a round of great interest and truly remarkable hospitality. Mr. and Mrs. Harald Stridsberg welcomed me to their lovely home at the Fammarps Gardens, about which we publish an illustrated article in this issue. I can still taste their mushroom omelette.

At six o'clock that evening we were entertained in the Wendler home to a magnificent dinner in the traditional Swedish style. First the snapps (not "schnapps," I had earlier discovered) which is guaranteed to thaw any ice. ("Never sip it; knock it back!" rashly advises an English guide-book to Sweden). In another room was a large table spread with the incredible smorgasbord, with delectable spiced herrings, sardines, salmon, lobster, shrimps—to mention a few of the *hors d'œuvres*—for this feast was merely to introduce the superb dinner itself (in yet another room, warm, candle lit) with a wealth of toasts in caressing wines.

The English language contains many, many more words than the Swedish, but my grasp of it is inadequate to cope with a description of that evening. I recall with horror my first meeting with Miss Wendler and the Stridsbergs, Miss Ingrid Ohman and Mr. Westin at dinner in a Peterborough hotel during the 1950 International Conference.

On another day I visited the shelf and tray farm at Partille which supplies the Gothenburg restaurants, and then continued what would best be described as the Wiberg Introduction to Snapps. What a selection! I recommend old Aquavit and Aquavit Loejten particularly, though Skone and OP are excellent, and Bords is something to remember on a cold day.

My arrival in Sweden had led me to expect an unusually cordial reception. Mr. Westin was at the airport to drive me into Gothenburg, and with Mr. Wiberg gave me more than an inkling of the lavish hospitality which was to follow. Miss Ohman telephoned me on my arrival to invite me to Stockholm and, as I had too little time to accept, came over herself (300 miles, is it?) to welcome me and to talk about mushrooms. She went with us to Fammarps, and then trained back to Stockholm (400 miles?)

The long busy days went by in a flash. What a consolation it was each morning as I woke up, to see across the square the Apoteket Vasen. Bless the Scandinavian dispensers!

As Guy de Man and I parted ways a week later at Copenhagen Airport, we toasted the friendly Swedes as they had toasted us. "Skal!" we cried—and this time we did knock them back.

Fred C. Atkins.

AREA MEETING, HALMSTAD, SWEDEN, 3rd FEBRUARY, 1953
Left to right: Mr. Wendler, Mr. de Man, Mr. Westin, Miss Ohman, Mrs. Stridsberg, Mr. Wendler, junr., the Editor, and Mr. Stridsberg

Stanley Middlebrook's Diary

Jan. 8. " Barrows, coach built . . ." runs a Bulletin small Ad. Come Mr. Simons, what next ? Stable manure, attar of Roses. Trashing stools, Queen Anne. Chip baskets, golden caskets. Record cards, illuminated parchment. Chimney stacks, Tower of Pisa replicas. Income, tax free. " Barrows, *coach* built " indeed. Bath chairs, plush perhaps, for the oldest employees !

Jan. 16. Searching for the water leak mentioned last month, we have uprooted quite an amount of concrete. We were surprised to uncover no less than two full bags of unused cement in the hard core—a concrete version of the five o'clock " down tools " system. A loss of over 300,000 gallons sprang from a leak in the main between two Handcraft huts. As the water hadn't found the drains the Handcrafts must have been converted into temporary rafts.

Jan. 20. Talking to Mr. Luxmoore to-day, I took him up on his point (last month) that " bishops " are due to creosote. He argued that if creosote coincided with any other trouble he would blame it for that too. Very circumstantial, I think. Another grower has blamed creosote for his rosecomb. A third has rosecomb badly but never uses creosote. A fourth puts all his boards in *boiling* creosote and claims he gets no disease. (*See p. 89—Editor.*)

Jan 21. Said an eminent Southern grower to me to-day. " You and Dr. Sinden are responsible for more trouble in the South than truffle, verdigris or any other disease." (It is humiliating, Dr. Sinden, to learn that you and I are placed in the disease category!) And why? I asked. " Short composting, of course." If this is true—which I doubt, because people will continue to evolve their own methods of short composting and call them Dr. Sinden's or mine (if they fail) and blame us for the failures—if it is true I must take most of the blame. My adaptation of Sinden's method—never called Sinden's, note—cannot tolerate the latitude he claimed, a point that I've repeatedly tried to make clear. If growers get better results by their own methods than I do all well and good. They don't complain. But we at Brayton can't fool around with our adaptation and why should growers blame me if their fooling around lets them down?

Jan. 23. My young son was watching us splodging about with wooden hand-made agitators in a tank containing a porridge-like mess of synthetic material being made up into an experimental casing medium. He gave the process some careful thought then observed " Who said mushroom growing isn't scientific?"

Jan. 26. I cannot recommend the use of so-called " steam proof " $\frac{1}{2}$" Gyproc board for a ceiling lining. It is certainly not proof against the steam applied at peat heat. It will last perhaps two crops before it buckles so badly that it falls out of place.

Jan. 27. One hears reports on all sides that production is down; crops are not up to standard, are slow in appearing and so on. Some

are suffering from excessive disease (we are in this group), one has lost several crops through mites, another who used to do his $1\frac{1}{2}$ quickly and easily on trays is now down to a hard 0·7 and can't get more. Eelworm appears to be prevalent. One man, thoroughly disgusted with his production curve, is taking the unusual step of clearing out all his staff and starting afresh. Yet the markets are glutted and prices low.

Jan 28. How much of the above poor cropping (not disease, mites, etc.) is due to the effect of frost at some stage or stages of the process? Frost dries up the air—temporarily at any rate—and this may be bad for composting (especially " short ") and probably worse for house humidity during cropping. We have to water beds about twice normal during a frosty period and we know excessive watering reduces soil aeration.

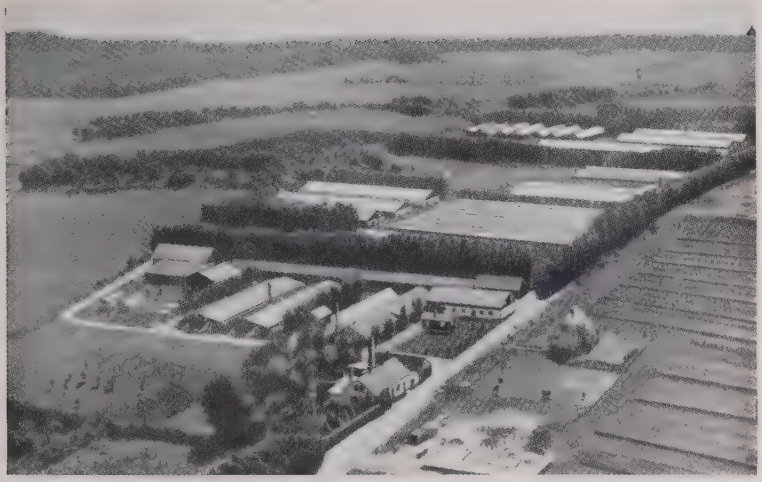
Jan. 31. More and more people seem to be using synthetic compost with apparently satisfactory results. We must be reaching our dotage in Brayton—we're still on shelves and still using horse manure. We are, it would seem, no longer progressive and at the moment we just don't care!

Feb. 2. Two respectable clumps were picked from a first flush. One with 113 mushrooms gave 6 lb. 3 oz. The other 106 for 5 lb. 8 oz. They both represented about 4 lb. per sq. ft. There were blank areas round both clumps but to-day at the second flush those areas have filled up and produced quite heavily. I had feared those areas were exhausted by the first flush drag on them.

Feb. 4. There are several formidable barriers in the way of our drive for more growing houses. We can't decide what type to build; the increasing costs of building (up again this week it seems); more growing houses mean more composting sheds—still more capital; our soil supply has been suddenly and unceremoniously cut off; increasing production costs lined up with decreasing mushroom prices; vanished capital. Any more barriers? Yes. My accountant; the inspector of taxes; *and* his pal the collector of taxes. So we can't build. Or shall we?

Feb. 5. Here's something for the spawn makers and the research pundits to worry about. The strain of a certain spawn is said to be " giving out " because it is producing here and there gill-less mushrooms —a sure sign according to one authority. We have that spawn growing in ordinary soil and in a synthetic casing in the same house. Mushrooms from the ordinary soil have dark brown gills—as usual on this place. Mushrooms on the synthetic casing have very light pink gills, mainly anaemic pink and in many cases the outer edge of the gill disc is practically gill-less. In a few cases they are completely gill-less. Now why a difference in the gill colouring between two casings and why weaker gills on the synthetic material? Is a pink gill the middle stage between dark brown gills and complete gill-less-ness?

Feb. 6. The most enterprising grower I know, who has all-electric heating and was apparently trained in a school of science and economy, declares that he is not wasting his time when he stands for hours on end retarding the progress of his electric meter by means of a powerful magnet.



MY WAY OF GROWING

9—Harald Stridsberg, of Sweden

When I was asked to write an article for this series I was at first somewhat hesitant. In over 20 years during which I have been growing mushrooms, my way of growing has changed several times and is still changing from year to year. However, I will try to tell you something about the methods used during the last 12 months and especially something about the change from the shelf bed to the tray system started in the autumn of 1951.

"The Fammarp's Gardens" were founded in 1933 in an old pigsty, 30 × 120 feet, and have since developed to a bed surface of around 270,000 square feet in 1951, one third being in summer houses with no heating.

The winter houses are built of concrete, sawdust insulated, and with roofing of corrugated asbestos-cement. Against the walls are high embankments to protect them against the cold of the winter and the heat of the summer. Each house is divided in 4 rooms, each room holding 2,420 sq. ft. of shelf beds or 4,300 sq. ft. when using the tray system.

During the winter of 1951-2 the method was changed in one-third of the rooms from shelf beds to trays. To meet the air requirements of this increased bed surface, **air-conditioning** has been installed, bringing heated, damped air into the room, changing the air four or five times an hour, yet causing no draught. To prevent the spread from one room to the next of any disease through the air ducts, each room has its own separate air unit. All boilers are oil-fired.

The trays are made of first-class Cuprinol-impregnated wood. The inner measurements of the trays are 27″ × 24″ × 6″. The ends are one inch higher than the sides and have holes to simplify handling.

The handling of the trays is mechanized as much as possible. The trays are filled with manure in the composting house, whence they are transported on conveyors to the peak-heating room, where hot air and live steam are available.

The peak heating and cooling down take around five days, and then the trays are carried on conveyors to the growing room. During this move the trays are spawned.

After three weeks in the growing room, the trays are transported to the cropping room ; during this move they are cased. **We are, in fact, using a three-zone system.**

Cropping starts five to six weeks after spawning and is continued for a period of two months. Then the trays are emptied by means of an elevator. *The empty trays are cleaned with compressed air*, sterilized with formalin, and returned to the composting house. The emptied cropping room is also sterilized, with formaldehyde released by potassium permanganate. This system gives four to five crops a year, compared with two crops when using the shelf beds.

The manure in the trays is 5″ thick, whereas it is 8″ in the shelf beds. The crop per square foot is also smaller in the trays compared with the beds, but on the other hand **the crop per ton of manure is around 25% greater with trays.** This is particularly important, because the supply of manure is decreasing each year and the price increases correspondingly. The quality also is now much poorer than a few years ago.

We are using the short method of composting and are adding gypsum, superphosphate and sulphate of ammonia. We have also obtained acceptable results with MRA synthetic compost. In the winter, however, there are certain difficulties connected with the wetting of the straw, as here it often turns into a complete iceberg. Therefore we shall use horse manure as long as it is available.

The casing soil here at Fammarp is a light sandy loam. We have undertaken several experiments with other types of soil and also tried out different methods of making lumpy soil, but have not had any better crops than with our usual loam.

The only spawn used here is grain, which we culture ourselves. However, comparative experiments with spawn of other types and cultures are continuously going on.

White mushrooms are mainly grown, the demand for brown ones being very small in Sweden. This is regrettable, for the brown mushrooms are easier to grow and give a better and quicker crop; the brown Lambert Strain No. 50 has hitherto given the best results.

All mushrooms intended for fresh sale are picked direct into cardboard boxes holding 2 lb. each. When picking, the boxes are placed in special frames hung on the trays; each holds three boxes and a tin container for the choggings. The filled boxes are conveyed into the refrigerating chamber, where they remain till the afternoon, when they are weighed, packed and transported to the railways.

Annual production of mushrooms here has been around 550,000 lb.; of this production about 200,000 lb. are sold fresh and 350,000 lb. canned in our own cannery. Some of the cans are exported, but the main part is sold on the domestic market.

Through the change-over to the Tray System the estimated production in 1953 will increase to around 660,000 lb. All costs, such as wages, packing material, manure, transport, etc., have gone up considerably in the last few years, but the sale price of mushrooms

has not risen proportionally. To meet this situation we have mechanized as much as possible and continue our efforts.

I take this opportunity to express my great gratitude to the Mushroom Growers' Association and the Mushroom Research Association for their pioneer work in the field of mushroom cultivation, and for the numerous articles of considerable value which have appeared in the MGA Bulletin—a magazine always longed-for with great interest.

PROGRESS IN FRENCH RESEARCH

In his New Year message to members of the French Federation, **M. Guiochon,** their President, remarks on the growth of interest in their Research Station and in improved methods of growing generally. He says that some 30 growers have already, or are preparing, heat rooms for tray culture, some of these are already in successful use, and mechanisation is growing rapidly. Many growers who have until recently disregarded turning machines now find them indispensable.

Towards the end of 1952 important developments occurred in French mushroom growing and particularly in the field of research. During the past few years interest has been growing rather slowly except among a few leaders of the Industry, but several local groups have now joined forces to conduct experiments among themselves and to support the Research Station at St. Cyr on a mutual aid basis. Plans have also been made by **M. Sarazin,** well-known as a scientist and producer of spawn, and **M. Delmas** of the Research Station at St. Cyr, to carry out an exhaustive study of the process of fermentation which goes on during composting. They decided that the work already in progress at St. Cyr on the application of peak heating and of addition of fertilisers to manure, could not be fully effective because they lacked enough fundamental information about the fermentation process itself. They propose to set up a rotating drum of about 6 cu. yards capacity in which commercial quantities of manure could be fermented under controlled conditions of temperature, moisture and aeration, with addition of any desired fertilisers. They estimate that a single complete experiment with this apparatus would involve over 1,500 analyses, lasting over a period of three months. At the same time the micro-organisms and biological changes taking place in the compost would be studied. No other country has ever undertaken an investigation of compost or the composting process on this scale and it will be an event of the greatest scientific importance.

An Appeal has been launched under the auspices of the French Mushroom Growers' Federation to raise one million francs (about £1,000) for this project, and it is to be hoped that the Appeal will meet with an early success so that the work can be put in hand.

The growth of interest and progress in France is likely to continue even more vigorously in the coming year. **R.L.E.**

F. R. FRAMPTON *describes*

ANOTHER HEATING SYSTEM

High Velocity Low Pressure Hot Water

In *MGA Bulletin* 35, F. R. Frampton wrote: "I was disappointed not to see an article on high speed hot water (not high pressure) in your Special Heating Number." Several members at once wrote in· "What system is this?" The Editor asked the writer for an article, and here it is.

I define this system as being one in which the temperatures of the flow and return are sufficiently close that the pipe shows no significant change in heating power along its length. In practice this is best done in $1\frac{1}{4}$" to 2" pipes according to length of the loop, the temperature difference being about 15° F. For economy of pipework the layout should be planned to have a maximum water temperature of 180° F.

The system uses a normal hot water boiler and a pump large enough to circulate the water at a speed such that it only has time to cool 15° F. by the time it gets back to the boiler.

In closer detail the system consists of the following:—

The Boiler: Any hot water boiler will do. Existing sectional or tubular boilers can be used, but it makes thermostatic control very much easier if there is forced draught—which is, in almost all but the smallest units, a paying proposition.

The Pump: The pump must be designed so that the water can pass through it when not working. It is usual to put the pump on the return, but it is not done in this system because it would involve putting the air pipe and expansion tanks too high above the boiler. It must be designed to pump hot water.

The head or pressure of the pump should be calculated to give the correct rate of flow in each loop, the capacity (gals. per hour) should be equal to the rate of flow per pipe multiplied by the number of pipes. The horse power of the pump is dependent on both the head and the capacity.

Pumps should not be put near boilers as boiler dust greatly increases wear and tear. If ordering a sizable pump be sure to get several quotations because pumps, more than anything else, seem to vary unaccountably in price.

The Mains: Properly sized ring mains are essential (they are on any good hot water system), the point being that, no matter which heating loop the water passes through, it travels through the same length of main. Headers or junction boxes are desirable where mains branch, and all valves should be of the "gate" variety. Where the pipes are 4" in diameter or less and "class B" wrought iron pipe has been used, cold pipe bending can be done on the site, saving much time and money. One of the joys of such a system is that there is no need to trouble about levels as the water forces all air in front of it. It is even possible to take a pipe up over a doorway and down the other side without bothering about an air tap.

The Heating Loops: These can be placed just where they are wanted. It is as well to remember that the lower the pipe the more efficient it is, but the higher the pipe the more even the conditions. Great economy of space in peak heating sheds can be obtained by

using gilled pipe. Gilled pipe is also useful for warming a consistently cold end of a shed. If unions or rubber hoses and jubilee clips are used at key points, pipes can be moved out of the way in a few minutes with negligible loss of water, thus giving greater scope for mechanisation when moving trays or beds.

The Expansion Tank: This should be large (never less than $3\frac{1}{2}\%$ of the total capacity of the system) and should be on the return side of the boiler without a valve between the tank and the boiler. In this way cold water can always be supplied to the boiler by means of a ball valve placed at the *bottom* of the tank.

Automatic Control: Normally a well sited thermostat working on air temperature in the shed is connected to the F.D. Fan. This gives excellent results.

A novel feature is a combined thermostat and humidistat which includes the ability to dry out excessive moisture on warm damp nights.

Advantages compared with a 4″ low pressure system:

2″ pipe costs less than half 4″ pipe.

Erection time and costs are very much lower.

Pipe benders can be used, thus saving time and fittings.

There is no need at all to level the pipes.

Pipes can be shifted to suit plant spacing.

Far less room is taken up. No piers are necessary. We planted 12% more carnation plants in one house.

The smaller thermal capacity of the system gives a quicker heat response. This in turn, gives unusually even temperatures.

The boiler can be at ground level.

Advantages compared with the low pressure steam system:

Complete flexibility with only one thermostat.

No thermostatically controlled motorised valves.

No strainers and steam traps.

No water injection pump.

N.B.—The above have to be paid for, can go wrong at a critical time, and can be costly to maintain.

Lower heat losses from the external surfaces of the boiler which, unlike a steam boiler, are only hot when there is a strong demand for heat.

A water boiler is inherently more efficient than a steam boiler because the lower temperature of the boiler plate enables more heat to be extracted from the flue gases.

Existing cast iron or relatively cheap mild steel boilers can be used.

Lower insurance. (About £10 per acre per annum.)

The expansion tank, although large, is less costly than a steam drum.

Disadvantages of the system:

There is no steam for sterilization.

Pumping costs are high, but it should not be forgotten that some of this is returned in heat. (Fluid Friction.)

To sum up, I say that this is the cheapest system to instal, the most efficient as far as heating value per lb. of fuel is concerned, and in my view will give as good or better conditions in the house than any other system.

What more could one want?

My Favourite Recipes

3.—Mrs. George W. Baker

Here are four of my favourite recipes which have proved very popular and do not deprive the farm of marketable mushrooms.

Pickled Mushrooms

For this I use all mushrooms that are too small to market, when a house is emptied—in fact the smaller the better.

Cut off the root and wash the mushrooms. Place them in layers in a preserving pan, alternating each layer with a liberal sprinkling of salt. Stand pan over a very low heat and periodically shake about until the mushrooms are cooked. Put into jars together with some of the liquor which they will have made during cooking and then fill up the jars with cold boiled vinegar. Add one peppercorn to each 1 lb. jar and seal. Leave for about a fortnight before using.

Scallops and Mushrooms

Allow 1 scallop and 1 oz. mushrooms for each person. Wash and cut up the mushrooms fairly small. Simmer gently, together with the scallops, in milk and water until tender. Drain off and make a white sauce with the liquor (add more milk if necessary). Place the scallops in their shells and cover with the white sauce, adding the chopped mushrooms.

Mushroom Soup (My own pet recipe)

Ingredients:—

1 lb. mushrooms (stalks will do)
1½ pints water
2 oz. margarine
2 oz. flour
1 pint milk

Simmer the mushrooms very slowly for 1½ hours. Make a sauce of the fat, flour and milk and strain into it the water in which the mushrooms were cooked. Season to taste. Add a few button mushrooms for garnish.

Stuffed Mushrooms

4 flat mushrooms
1 dessertspoonful chopped cooked ham
1 tablespoonful breadcrumbs
1 teaspoonful finely chopped onions
1 teaspoonful chopped parsley
½ oz. butter
pepper and salt
1 tablespoonful white sauce

For dishing:—4 croutes of fried bread
To garnish:—Coralline pepper

Wash the mushrooms. Trim to equal-sized rounds, with a cutter, if necessary. Chop the trimmings finely. Fry the onion and the chopped mushrooms in the butter for 10 minutes. Add the other ingredients with sufficient sauce to bind. Pile this mixture on the under-side of the prepared mushrooms. Put on a greased tin, cover with greased paper and bake until soft in a moderate oven, about 20 minutes. Dish on the fried croutes and decorate with coralline pepper.

Battersea Polytechnic Cookery Book.

TRACE ELEMENTS FOR MUSHROOM CULTURE

By **Dr. B. B. STOLLER**

Mineral Elements and Nutrition

In plant nutrition the major or " macro " mineral elements essential for plant nutrition are potassium, phosphorus, calcium and magnesium. Other major elements required—carbon, oxygen, hydrogen, nitrogen and sulphur—are not considered usually as minerals, especially the first three; the reason for this distinction is that these elements volatilize when the plant material is burnt in making ash analysis—if not present in the ash, it is not a mineral. The essential minor or " micro " or trace elements—so-called because they are required only in minute quantities or " traces "—are iron, zinc, boron, manganese, copper and molybdenum (9). There are many other elements found in plant materials, such as silicon, sodium, chlorine, etc., but these are considered non-essential. The necessity of an element in plant nutrition is demonstrated only if lack of it can be shown to result in injury, aberrant development, or death of plants when grown in sand or solution cultures, and also if no other element of similar properties can be substituted for it (9). Except for boron, fungi or moulds require the same essential elements (11). In actual practice, though, many other trace elements are employed for the nutrition of both green plants and moulds in order to satisfy strain or species specificity, to obtain high yields of plant products, and to resist diseases. Some of the other trace elements which have been found effective for these uses are as follows: aluminium, bismuth, bromine, cadmium, cobalt, chromium, gallium, iodine, lithium, nickel, rubidium, strontium, tin, titanium, and vanadium. The question is how to make a selection among these trace elements that may be advantageous to mushroom culture.

Selection of Trace Elements for Mushroom Culture

The bases for selection are: (1) the mineral composition of the mycelium and sporophore of the cultivated mushroom as well as that of closely related mushrooms; (2) the mineral requirements and responses of the mushroom mycelium in laboratory cultures; (3) effect of minerals in experiments with composts; (4) striking results with minerals observed in the physiology of fungi in general. The last will be discussed now, the others later.

Bromine as sodium bromate is said to have a stimulating effect on the growth of yeast (1). Cobalt is known to substitute for and supplement manganese as an accelerator of enzyme activity. Cobalt is a constituent of Vitamin B_{12}; the latter has been detected in horse manure,

but not in mushrooms (10). Gallium is now considered essential for *Aspergillus* (13). It greatly affects the yield of this fungus and influences the utilization of carbon dioxide (13). Iodine tends to promote the formation of phenol oxidases of *Polyporus* (8). Nickel was assimilated by *A. niger* and gave increased yields; it also increased sugar consumed per unit of dry weight by *P. glaucium* (5). Vanadium was found to be present in all fungi examined; the yield of *A. niger* was increased 20% by addition of vanadium to the medium (16). The role of essential trace elements is discussed below.

Functions of Trace Elements

The trace elements were regarded at first as poisons, which stimulated an increased but abnormal growth when tremendously diluted. In 1920, however, Steinberg (11) introduced a procedure for the purification of the nutrients for growing fungi, so it was possible to show that increases in yield of 5,000%, or more, could be obtained by adding trace elements. It is recognized now that trace elements are required for normal growth and sporulation of fungi; but how these elements influence growth has been uncovered only recently. The basic function of trace elements appears to be to activate enzymes. Many enzymes consist of a protein complex or " chelate " together with a trace element, called the accelerator or " prosthetic " group. For example, the polyphenol oxidase of the mushroom is a copper protein. A copper molecule itself can oxidize only one molecule of catechol, whereas the same copper molecule as part of the protein enzyme can oxidize 70,000 molecules of catechol over the same period of time—shows how powerful enzyme combinations are.

The functions of the essential trace elements are known as follows :

1. Growth of mycelium. The greatest response to growth of mycelium is effected by zinc and iron, and less by manganese, copper, molybdenum and gallium (15).

2. Sporulation. Copper and manganese exert the greatest effect on sporulation (15), and presumably on fructification.

3. Enzyme activation. Iron is a prosthetic group of the porphyrin-type enzymes, such as the cytochromes, which function in cellular respiration. Zinc, copper, manganese, and cobalt are accelerators of the oxidases, carboxylases and proteolytic enzymes.

4. Precipitants of nitrogenous substances. The trace elements, which are heavy metals, may serve as precipitants, coagulents or flocculents of nitrogenous and other colloid materials of the compost.

5. Antagonism. It is known in plant physiology that some degree of antagonism exists between almost any pair of salts (9). A whole group of trace elements will tend to compensate for the toxic or unbalancing effect of any particular element.

6. Amino acid and nitrogen metabolism. Iron, zinc, copper, manganese, molybdenum and gallium are required with amino acid nitrogen as well as inorganic nitrogen (14). Minute quantities of these

elements are retained tenaciously by amino acids. Molybdenum seems to be of special importance in the reduction not only of nitrates but of nitrites and of other nitrogenous salts (12).

7. Utilization of carbon dioxide. Gallium, zinc and iron play a specific part in the utilization of carbon dioxide by *Aspergillus*, presumably for reactions leading to synthesis of organic acids (13).

8. Cell-wall formation. Boron limits the maintenace of an effective level of calcium in a soluble or active form. Lack of calcium, in turn, is associated with failure to develop pectic compounds and cell walls. Accordingly, cell-wall formation is interrupted when there is a deficiency of boron.

9. Disease. The addition of manganese to a medium encourages the growth of the " false truffle," *Pseudobalsamia microspora*, in association with the mushroom mycelium under conditions where it is not able to grow without manganese. It is not known whether the same effect would be produced in a compost containing all the trace elements.

Analyses of Mycelium and Sporophores

It is improbable that the composition of the mycelium from submerged culture or even surface liquid culture is the same as from that of a compost. It has not been possible to separate the mycelium from the compost; however, the mycelium of a wood-destroying fleshy fungus which completely disintegrates the wood, may furnish some information about the mineral composition of a mycelium. The analysis of the substrate, mycelium and sporophore of *Merulius lacrimans* is shown in Table 1. Although this analysis was made in 1885, the authority of Zellner who has analyzed many of the higher fungi, besides the close similarity of the analysis of the sporophore with recent analyses, would indicate that it is reliable. The mineral composition of sporophores of diverse fungi, including *A. campestris*, has been shown to be generally similar (6), so the same might be assumed for the relative composition of their mycelia. Notable in Table 1 are the large concentrations of aluminium (Al), iron (Fe), and manganese (Mn) in the mycelium compared to the substrate; then the sharp decrease of these elements in the sporophore. This decrease in the sporophore may exemplify that these elements are not easily transferable and that their greatest activity is exerted in the mycelium.

The absorption and detection of elements in plant materials does not necessarily mean that they will be utilized. Not only may the quantity of element present in plant materials, but also the many kinds, be misleading in regards to utilization. But when an element is detected in the composition, it should be a basis for testing its effect. Some 40 elements have been found in plant materials by chemical analysis, although only 15 to 17 are considered essential. Copper has been detected in the mushroom sporophore (2), as might be expected from the large amount of oxidases it contains. No analyses have been made for trace elements other than those shown in Table 1 except for copper; presumably others are present in very minute quantities.

Table 1. Mineral Composition of Mycelium and Sporophores

	Healthy* wood	Mycelium* (wood destroyed) *M. lacrimans*	Sporophores *M. lacrimans**	*A. campestris*†
K_2O	8·6	7·2	56·1	44·0
Na_2O	0·9	5·5	1·6	2·3
MgO	4·8	1·8	Trace	0·2
CaO	36·6	31·0	0·4	1·3
$Fe_2O_3+Al_2O_3$	4·8	11·2	4·0	2·6
Mn_3O_4	0·8	4·4	Trace	Trace
SO_3	2·9	4·0	2·6	3·0
P_2O_5	2·6	0·9	25·0	24·3
Total ash	0·2	1·5	9·7	11·5

*modified after Hasenohrl and Zellner (7). †Friese (6).

Effect of Trace Elements on Mycelial Growth

The mineral requirements for maximum mushroom mycelial growth are not easily shown, because the requirements are so minute. Bechmann (3) claims to have obtained a stimulation in the growth of the mushroom mycelium with zinc, iron and boron, but not with copper. Treschow (20), however, doubts whether any significance can be attached to Bechmann's results because he employed a medium with too high sugar concentration and too strong phosphate buffers, so that growth of the mycelium was very slow and irregular. Treschow did not observe any effect of the Cu, Zn, or Mn on growth of the mycelium, although a trace of Fe was required. Stoller (17) proposed the use of such trivalent ions as Al, Fe, and Mn to improve the growth of the mycelium, not only because they were effective flocculents, but also because they were present in large amounts in mycelium as shown in Table 1.

The writer has tested many of the more common trace elements by mixing them with washed manure, according to the usual procedure in making spawn. No toxicity was encountered as long as minute amounts were used, as would be the practise in making composts. The translucent mycelial growth produced with larger quantities was overcome by mixing with lime or calcium carbonate. The trace elements are almost all heavy metals which are precipitated as insoluble carbonates by the carbon dioxide of the fermenting composts, or coagulated or flocculated by nitrogenous and other colloids of the compost, or are precipitated out by the calcium carbonate of the compost. In fact, precipitation with $CaCO_3$ is the procedure employed by Steinberg, previously mentioned, for the purification or removal of these elements from nutrients. The insoluble salts of trace elements resulting from precipitations are, however, available to roots of plants and the mycelium by " contact exchange."

While it would be going too far afield to discuss such recent scientific concepts as " contact exchange " and " chelation," nevertheless a few remarks are necessary to elucidate the manner in which the trace elements are absorbed. According to the contact exchange theory water-insoluble trace elements are directly (by-passing the soil solution) replaced by or exchanged for hydrogen ions furnished by organic acids

synthesized by the mycelium. In consideration of the fact that oxalic acid is produced by the mushroom mycelium, and also the fact that it has been shown oxalic acid is more efficient than other acids at same concentration in releasing absorbed cations, it is likely that the oxalic acid of the mycelium operates in a mechanism of this kind in order to make available for absorption the insoluble trace elements. However, it has been reported recently that in plants showing iron deficiency (chlorosis-pale leaves), addition of large amounts of iron sulphate ($FeSO_4$) in solution to the soil failed to correct this condition, whereas addition of minute amounts of " chelated " iron quickly brought about greening of the chlorotic leaves (21). In other words, the soluble $FeSO_4$ was precipitated out by the phosphates, carbonates, etc. in the soil, and transformed into an insoluble form so that the iron was not available to the roots. On the other hand, the iron of the " chelate " cannot be precipitated out by these agents, so that the iron of the chelate is available to the root. " Chelates " are complex organic compounds which have the property of forming " loose " combinations with trace elements, etc. so that these elements cannot be precipitated out by common precipitating agents. The commonest commercial chelate is EDTA (ethylenediamine tetraacetic acid). It may be worthwhile to add chelates of trace elements to compost to observe for effect on production.

The only significant result from the writer's laboratory tests with the trace elements was their effect on *Pseudobalsamia microspora*, the fungus which causes the truffle disease. This fungus usually fails to grow on grain (as prepared for " grain spawn ") or on grain overgrown with mushroom mycelium (" grain spawn " itself). When certain trace elements are added to the grain, however, the truffle grows vigorously; grows both on the grain alone, or on the mushroom mycelium impregnated grain. The order of effectiveness of these elements are as follows: Mn> Fe> Zn> Cr> Co> Cu. Manganese encourages the most vigorous growth, especially an abundance of truffle fruiting bodies; whereas copper in many cases, particularly if the truffle inoculum was from old stock, prevented the truffle from growing on the grain. When Mn and Cu are mixed together the truffle usually fails to grow or is greatly retarded, especially the fruiting. Relatively large amounts of these trace elements are required to produce this response—about 0·1 to 0·2% at 50% moisture, or 0·5 to 1·0 gram of the salts to the usual 8 to 9 oz. of grain per bottle. The sulphates are more effective than the chlorides of these elements; in fact, sulphur compounds in general induce growth of the truffles. How these trace elements affect the truffle in the compost has not been studied.

Experiments with Trace Elements in Manure and Synthetic Composts

If the effect of the trace elements on the yield of mushrooms is to be learned, some start has to be made by adding the elements to composts and see what happens. The experiments reported in Table 2 were carried out by the writer in 1938; no further tests on singular elements have been made since then. In order for tests with trace elements to be reliable and practical, maximum yields have to be obtained. In the

tests reported, the yields are not considered maximums, although the yields are fair, considering the better control of insect and fungus pests that may be had to-day. Strictly speaking, the results apply only to yields in the range reported.

The synthetic straw compost was prepared with $\frac{3}{5}$ chopped straw and $\frac{2}{5}$ long straw; " ammophos " (16% N) and " calurea " (20% N) served as N sources; the rest of the formula was made up according to methods described (19), so that the N—P_2O_5—K_2O—was 11·8—4·0—12·5. The liquorice root composts employed have been described (19); urea was used as the source of N. The tests were carried out in boxes of 5·0 to 5·2 sq. feet; the boxes held 80 lb. manure (59% moisture), or 100 lb. root composts (66% moisture), or 50 lb. straw composts (moisture unknown), The trace elements were mixed with the composts at the time the boxes were filled, then placed on shelves for " pasteurizing."

From the results in Table 2, it may be deducted that when a group of trace elements such as No. 14 is added to a straw compost with an inorganic N source, an increase in yield of 20% to 30% may be expected.

This deduction was substantiated in plots of 48 sq. ft. carried out simultaneously: the yield of control of the plots was 1·54 lb. per sq. ft., whereas the yield after addition of trace elements as in No. 14, besides small amounts of boric acid, KBr and KI (18), was 1·87 lb. per sq. ft. When organic sources of nitrogen, however, were substituted for the inorganic sources, the yields were high even without trace elements; for example, with dried blood, yield was 1·64, with tannery sludge 1·66, and with cottonseed meal—1·87 lb. per sq. ft. The larger yields derived from the use of organic N sources may be attributed, at least in part, to the trace elements they contain. Edwards (4) has employed a combination of trace elements similar to these, but including molybdenum, with synthetic straw compost; he reported an increase in yield of about 20%.

The effect of the singular elements is difficult to appraise without further experimentation. It may be surmised that Zn, Fe, Mn, Cu, Al, and B are beneficial when applied as single salts, whereas bromides (NaBr) are very toxic, bromates ($NaBrO_3$) are very slightly toxic, and the KI and KF were without effect. The halogens (Br, I, F), though, were employed in much larger concentrations than would be required. The data on the controls of the root composts were lost, so it is not possible to make comparisons. Boric acid appears to be particularly stimulating with the root composts.

CONCLUSION

An increase in yield may be expected from synthetic straw composts prepared with inorganic N sources (including urea) to which is added a combination of trace elements (Al, Fe, Zn, Mn, Cu, and B). Whether an increased yield may be obtained with manure composts will depend on the size of the crop: if it is usually low, the use of trace elements may increase it. Gallium, cobalt, and vanadium should be tested with composts for their effect on yield. Similarly, the effect of chelates of trace elements should also be tested.

Table 2. The effect of trace elements on the yield of mushrooms. Trace elements added to manure and synthetic straw and liquorice root composts.

No.	Trace elements	Grams	Manure Compost lbs. per sq. ft.	Straw Compost lbs. per sq. ft.
1	$ZnSO_4.7H_2O$ (lime-140 grs.)	140·	1·4	1·6
2	,, (no lime)	21·	1·7	1·4
3	$MnSO_4.7H_2O$ (lime-280 grs.)	280·	1·7	1·6
4	,, (no lime)	56·	1·6	1·3
5	$CuSO_4$ (lime-85 grs.)	85·	1·4	1·8
6	,, (no lime)	21·	1·5	1·4
7	H_3BO_3 (lime-112 grs.)	28·	1·4	1·1
8	,, (no lime)	10·	1·7	1·4
9	NaBr	56·	0·0	0·1
10	,, ...	10·	0·9	0·7
11	$NaBrO_3$	15·	1·2	1·1
12	KI	10·	1·2	1·3
13	KF	10·	1·3	1·2
14	$FeSO_4.7H_2O$	56·		
	$Al_2(SO_4)_3.18H_2O$	28·		
	$MnCl_2.4H_2O$	56·	1·8	1·7
	$ZnSO_4.7H_2O$	28·		
	$CuSO_4$	21·		
15	as No. 14, double quantities....		1·7	1·8
16	as No. 14 plus H_3BO_3	10·	1·6	1·7
17	as No. 16 plus lime-335 grs.	—	1·6	1·8
18	NaBr	10·		
	KI	5·	0·8	0·6
	KF	5·		
19	NaBr	5·		
	KI	3·	0·9	1·1
	KF	3·		
20	as No. 18 plus H_3BO_3	10·	1·1	1·0
21	as No. 19 plus H_3BO_3	10·	1·3	1·1
22	No. 14 plus No. 18 plus H_3BO_3	10·	1·3	1·3
23	as No. 14, one-half quantities	—	1·6	1·4
24	as No. 19	—	1·1	1·0
25	as No. 23 plus No. 24 plus H_3BO_3	5·	1·5	1·7
26	$NaBrO_3$	10·	—	1·3
27	H_3BO_3	5·	—	1·5
28	Control (4 boxes)	—	1·3	1·3
			Liquorice Root Compost	
29	$MnSO_4.7H_2O$	56·	2·0	
30	,, ...	252·	2·0	
31	$FeSO_4.7H_2O$	56·	2·1	
32	,, ...	252·	2·1	
33	$Al_2(SO_4)_3.18H_2O$	8·	1·9	
34	,, ...	56·	1·7	
35	$CuSO_4$	8·	1·6	
36	,, ...	56·	2·2	
37	$ZnSO_4.7H_2O$	7·	1·8	
38	,, ...	56·	1·8	
39	H_3BO_3	4·	2·0	
40	,, ...	10·	2·2	
41	$FeSO_4.7H_2O$	0·12	1·4	
42	$ZnSO_4.7H_2O$	1·0	0·9	
43	H_3BO_3	0·6	2·2	
44	KBr	0·1	1·2	
45	,, ...	2·0	1·6	
46	KI	0·03	1·2	
47	,, ...	0·7	1·8	

REFERENCES CITED

1. Alexander, J. Colloid Chemistry, N.Y. (1937).
2. Anderson, E. E. and C. R. Fellers. Proceed. Amer. Soc. Hort. 41, 301 (1942).
3. Bechmann, E. Ztschrt. Bot. 22, 289 (1929).
4. Edwards, R. L. MRA Report (1946-1948).
5. Foster, J. W. Bot. Rev. 5, 207 (1939).
6. Friese, W. Zeit. Unters. Lebensmit. 57, 604 (1929).
7. Hasenohrl, R. and J. Zellner. Monatsht. F. Chem. 43, 21 (1922).
8. Lindeberg, G. and G. Fahraeus. Physiol. Pl. 5, 277 (1952).
9. Meyer, B. S. and D. B. Anderson. Plant Physiology 2nd Ed. N.Y. (1952).
10. Miller, D. C. and A. C. Groschke. Mich. Agr. Exp. Sta. Bull. 32, 279 (1950).
11. Steinberg, R. A. Bot. Rev. 5, 327 (1939).
12. Steinberg, R. A. J. Agr. Res. 59, 731 (1939).
13. Steinberg, R. A. Pl. Physiol. 17, 129 (1942).
14. Steinberg, R. A. J. Agr. Res. 64, 455 (1942).
15. Steinberg, R. A. Soil Sc. 60, 185 (1945).
16. Steinberg, R. A. Bot. Rev. 16, 208 (1950).
17. Stoller, B. B. U.S. Pat. 2,189,303 (1940).
18. Stoller, B. B. U.S. Pat. 2,260,201 (1941).
19. Stoller, B. B. Pl. Physiol. 18, 397 (1943).
20. Treschow, C. Dansk. Bot. Arkiv. 11, 1 (1944).
21. Stewart, I., and C. D. Leonard. Sc. 116, 564 (1952).

The Copyright of this article is held by the Author.

RESEARCH IN SWEDEN

" We are going to start some research in Sweden on mushrooms; already we are studying one or two diseases," Mr. A. Wiberg, of Gothenburg, told the Editor a few weeks ago.

There are only 15 mushroom growers in Sweden at the present time. They produce about 500 tons annually. The sale price recently has been similar to that in England, but the demand is limited, and it is sometimes a problem to dispose of the day's pickings. Research may therefore be designed to promote efficiency rather than increase production.

The Swedish Preserving Institute in Gothenburg has a £40,000 p.a. programme under the direction of Professor G. Borgstron. Sixty per cent. of this money is found by the Government, the remainder by the food industry and the principal canners. Mr. Wiberg is a member of the board and secretary of the finance committee. Among his interests are two mushroom farms operated in partnership with MGA member Mr. G. Westin.

OPEN DAY AND REFRESHER COURSE

A **Refresher Course** will be arranged in Peterborough on Thursday, 16th April, by the Mushroom Research Association, to follow the **Open Day** at Yaxley on Wednesday, 15th April.

The following talks will be given: Eelworms as a pest of mushrooms, by B. D. Moreton (N.A.A.S. Wye); Some results of the use of zineb on parasitic diseases of the mushroom, by A. D. Harrison (N.A.A.S. Wye); Laboratory examination of composts, casing soils and mushrooms, and its value to the grower, by Miss D. G. Gandy and P. B. Flegg (MRA); The use of copper sulphate as a selective fungicide in compost, by Miss Gandy (MRA); and Some artificial mixtures used in casing soil experiments, by R. L. Edwards and P. B. Flegg (MRA).

The charge for the course will be one guinea per person. Applications should be sent to The Director, MRA, Yaxley, with a cheque *payable to the Mushroom Research Association Ltd.* Details of time and place will be sent later to those attending the Course, who are advised to book hotel accommodation as soon as possible.

PERFECT COMPOSTING

with

'THE CHATSWORTH'

Manure Turner

This robust machine, powered by a 5 h.p. electric motor, is designed to cut down labour costs and to speed up the composting process. It ensures thorough aeration and efficient teasing giving improved fermentation and increased absorption of moisture in the early stages of composting—an invaluable asset for rapid fermentation systems and for the preparation of synthetic composts.

'THE CHATSWORTH' Manure Turner is compact and easily manœuvrable in narrow or restricted areas such as small turning sheds or glasshouses, but is equally at home on the largest mushroom farm. A unique feature is a combination of specially designed beaters which ensures that both lumps and droppings are efficiently broken up.

'THE CHATSWORTH' Turner is already in use on a number of leading mushroom farms where drastic reduction of turning costs has been achieved.

Write for full details to

W. DARLINGTON & SONS LTD.

WORTHING, SUSSEX

RESEARCH ANNUAL MEETING

The Annual Meeting of the Mushroom Research Association was held in London, on 21st January, John Stewart-Wood, (Chairman) presiding. During the past year, growers and others interested had subscribed towards the cost of maintaining the Yaxley Station the sum of £1,575, compared with £1,445 the previous year, but salaries had increased by 15 per cent. Capital expenditure included the purchase of a compost turner and a steam boiler and the replacement of the original soil store. Fred. C. Atkins (Yaxley) was elected Chairman for 1953. Capt. G. P. Lawrence (Hants.) was re-elected Vice-Chairman, and Stephenson, Smart & Co. (Peterborough) re-appointed Auditors. At a subsequent meeting of the Directors, Dr. R. L. Edwards (Director of Research), reported on the arrangements which were being made for the Station's Annual Open Day on 15th April, and a Refresher Course at Peterborough on 16th April.

CONFERENCE IN BELGIUM

The Second International Conference on the Biology and Cultivation of Mushrooms will be held in Belgium, from 16th to 24th June, at the Institut Agronomique de l'Etat at Gembloux, about 35 miles from Brussels.

The Conference is being organised by CEREC, the Mushroom Research Centre there, under the auspices of the Institute for the Encouragement of Scientific Research in Industry and Agriculture and with the approval of the Ministries of Agriculture and of Public Instruction.

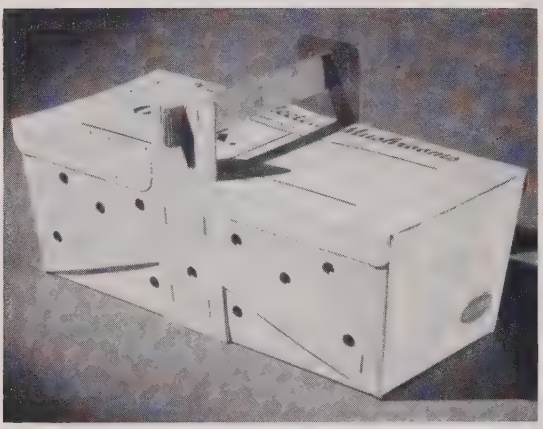
The object of the Conference is the scientific study of the biology and culture of the higher fungi for food and other purposes.

The following aspects will be studied: taxonomy, biochemistry, physiology, commercial growing, spawn manufacture, pathology and disease control. The papers will be presented in French or English.

The Conference will be divided into two parts. The first, from 16th to 20th June, will be devoted to scientific papers, the second, from 21st to 24th June, to visits to research centres, farms and factories where chemicals and other materials used by growers are made.

Professor A. Willam is Chairman of the Conference Committee. Dr. R. L. Edwards is a member of the Scientific Committee, and Fred. Atkins a Vice-President.

WORLD'S FINEST MUSHROOM BASKET



ONLY DRING BASKETS NEST SO PERFECTLY

ONLY DRING BASKETS STACK SO NEATLY

ONLY DRING BASKETS ARE SPECIALLY DESIGNED FOR THE JOB

ONLY DRING BASKETS CARRY A GUARANTEE

Acclaimed by growers, wholesalers, retailers **and** the press, the new Dring Mushroom basket is selling fast. Beautifully designed after months of experiment . . . after considerable trial and error, the Dring Mushroom Basket is the **finest mushroom container in the world.** Remarkably light, yet strong and rigid it is a veritable aid to sales. What is more, the wax impregnated board from which it is built absolutely eliminates all possibility of the contents being spoiled by the basket absorbing moisture. Independent growers have made certain of this by scrupulous testing. **That is why, alone of all mushroom baskets, the DRING carries a guarantee.**

DRING

DRINGPORT WORKS, THE AIRPORT, PORTSMOUTH, HANTS.

IT'S THE CHEAPEST IN THE MARKET

Dr. EDWARDS IN WORTHING

Dr. R. L. Edwards, Director of Research at Yaxley, spoke on Synthetic Mushroom Compost at a meeting in Worthing on 12th January, arranged by the Worthing Central Mutual Aid Group.

Mr. Harold G. Boxall, MGA Chairman and an MRA Director, who presided, revealed that he had now finished with horse manure and gone over to synthetic compost.

Dr. Edwards sketched the early history of the Mushroom Research Station and went on to enumerate the six major constituents and the ten trace elements which comprised the MRA formula. He described in detail the preparation of the compost. " It has the considerable advantage that the composition is always the same within the limits of purity of the fertilizers and straw used," he said, " and it can be started at any time, at short notice, since all the materials can be stored. I do not think the formula can be greatly improved but we may be able to simplify it a little and if, as we now hope, urea will become more freely available, this will greatly reduce the cost."

Mr. A. J. Passmore proposed the meeting's thanks to Dr. Edwards.

STANZAS TO STANLEY

Commenting on Mr. Luxmoore's suggestion in *A Question of Preservation* in our last issue Diarist Middlebrook ridiculed the suggestion that creosote fumes could cause the " cod's head " malformation described by the writer.

Mr. M. C. Luxmoore writes to the Editor: I cannot allow the strictures of Mr. Middlebrook to go unanswered. I ventured to remark " Those that *do* grow are often split, aping the bishop in chess " (in the vernacular, Cod's Head). Because Mr. Middlebrook has " bishops " through lack of FRESH AIR, this would seem to substantiate the claim that creosote fumes might also produce this phenomenon. There are also other causes of Cod's Head, of course, and I am sorry indeed that Mr. Middlebrook is suffering.

Mark Mr. Middlebrook, jumping the gun
To question page thirteen, when he is on one,
Confusing the issue before it's begun!
Like breaking a record before you can run.

The bishop at chess, the diminutive pawn,
The Coelacanth head in my mushroom spawn
Spewed from synthetic and maimed before born
By creosote fumes—to step on his corn!

Pepys mycological, couldn't you wait
Until the next issue to start to dictate?
In the game that I mentioned (to retaliate),
Moving too swiftly can cause a Fool's Mate.

THE **NEW**

Manupels

MANURE PELLET SPAWN

This completely new type of manure spawn is creating wide interest throughout the country, and preliminary reports of culture under the variable circumstances of individual farms is fully confirming the unique advantages of a manure medium.

Even at very economical rates of spawning it is found to provide an unusually rapid permeation of the compost —a factor of the greatest importance in the close schedule of tray culture.

MANUPELS—for rapid running, absence of mould growth and vermin attraction problems, and vigorous production of high quality, pure white mushrooms.

Full details from :

GEO. MONRO LTD.

HERTFORD ROAD
WALTHAM CROSS
HERTS.

Telephone : **Waltham Cross 3663** (*5 lines*)

DEPOTS : AYLESFORD, KENT ; GT. TOTHAM, ESSEX ; SWANWICK, HANTS. ; CHELTENHAM ; GLASGOW ; GUERNSEY ; PENZANCE ; ISLES OF SCILLY ; SPALDING ; WORTHING

KENT MEETING—21st MARCH

An Area Meeting has been arranged, by kind permission of Air Vice-Marshal Sir Conrad Collier, at Fairbourne Manor, Harrietsham, Kent (Maidstone approx. 8 miles) on Saturday, 21st March, at 2.30 p.m. A tour of the Mushroom Farm will be followed by a discussion, and tea will be available at a nearby Inn. All MGA members, together with wives and any staff, will be very welcome.

SEEN THIS?

The use of a trigger mechanism to cut off a spray instantaneously has been found very useful by mushroom growers for some years. Available at last is an oval Haws rose fitted with an Eclipse trigger assembly. This sprayer has been designed for easy handling and complete control, and any size of Haws rose can be fitted. J. E. R. Simons Ltd. are marketing it.

ITEMS OF INTEREST

Administrative: Our Secretary has been instructed to engage a full-time clerk so that, whenever he is absent on holiday, at area meetings, on committees, or through illness, the work of the MGA can continue.

Subscription: The Executive Committee is to recommend to the Annual Meeting (Harrogate, 29th September) "That the grower subscription remain at four guineas p.a."

Mr. F. L. Filmer has accepted re-election to the MGA seat on the NFU Glasshouse Committee and been thanked for past services.

Mr. Stanley Middlebrook joins the MGA Chairman and Vice-Chairman on the Harrogate Sub-Committee.

Executive Committee: It is to be recommended at the AGM "That the Executive Committee be increased to 15 members, including officers, and that five shall retire each year but be eligible for re-election."

NEW (JANUARY) MEMBERS

Chapman, G. W., Applehayes, Maer Lane, Exmouth, Devon.
Dippenaar, Professor B. J., University of Pretoria, Pretoria, South Africa.
Eguilaz, A. M., Avenida de lod Toreros 73, Madrid, Spain.
Groom, D. I., Irish Nurseries Ltd., Kimmage Road West, Dublin, Eire.
Haase, P. & Son, Lovstraede 8, Copenhagen K, Denmark.
Houpelyne, André, Singel 4, Bruges, Belgium.
International Heating & Ventilating Co. Ltd., 4 Denbigh Gardens, Richmond, Surrey.
Kublicki, S., Old Estate House, Wollaton, Nottingham.
Mantel, Dr. Erwin, Rheingau-Champignons, Rudesheim/Rhein, Germany.
Mullard, K. S., Andridge House, Radnage, Bucks.
Sjostedt, Sven, c/o P. Hakanssons Konserver A/B, Eslov, Sweden.
Wharton, J., 159 Northfield Road, Peterborough, Northants.

CHANGES OF ADDRESS OR TITLE

Elan Valley Products Ltd., Dol-Afallen, Llandrindod Wells, Radnorshire.
Bellido, Alfredo M. M., Diputacion 282, Barcelona, Spain.
Stacey, G., c/o Furber Road Nurseries, Furber Road, St. George, Bristol 5.

(*Italics indicate Honorary Membership*)

MAKE SURE OF A **"386 FRIGIMATIC"** PRODUCT

This illustration shows one of our many installations being used for mixed storage Safely Stored in a Refrigerated Cold Room

Rooms built to any size or specification. Enquiries welcomed and Quotations freely submitted. Ask our Representative to call, he will give expert advice

Plant designed for long or short term storage
Frozen Produce, Gas Storage for Apples, etc.

Brick Barns, Outhouses and Store Sheds converted into Cold Storage
all specifications guaranteed with "Frigimatic" installations

— COLD STORAGE INSTALLED BY —

R. C. DARLINGTON

HORTICULTURAL REQUISITES

HASTINGWOOD · HARLOW · ESSEX

(With Branches) Potter Street 138

pH— a vital factor in mushroom culture

With a B.D.H. Soil Testing Outfit you can determine immediately and in a practical and easily understood manner the precise *p*H of your growing medium. Full instructions accompany each outfit.

B.D.H. BARIUM SULPHATE
SOIL TESTING OUTFIT

Price 55/- from all pharmacists

Also, for growers on a small scale, B.D.H. No. 1 Soil Testing Outfit, 7/6

THE BRITISH DRUG HOUSES LTD.
B.D.H. LABORATORY CHEMICALS GROUP
POOLE **DORSET**

MUSHROOM FLY *or* "MAGGOT"

For best results do not rely on one method but use DEDETANE 50% DDT Paste or 10% DDT Dust, Nicotine Dust or Spray, HETP, and MURFUME SMOKES in succession at weekly or fortnightly intervals.

These products are described in our special Mushroom Booklet and a copy of our 1953 Spring Price List is also now available. The use of Murphy insecticides and fungicides makes mushroom growing more profitable.

THE MURPHY CHEMICAL COMPANY LTD.
WHEATHAMPSTEAD **HERTFORDSHIRE**

A SPECIALITY FOR MUSHROOM CULTIVATION

FRESH

LONG WHEAT STRAW

STABLE MANURE

Direct from Stud Farms and Racing Stables

PURCHASE FROM A FIRM WITH A REPUTATION WHICH KNOWS THE QUALITY OF MANURE YOU REQUIRE

Certified weighbridge Ticket with each consignment or load

Delivered by road or rail to any station or farm at reasonable prices per ton

*

GEO. WILKINSON

THORNBOROUGH DENE

LEYBURN, Yorks.

Telephone: LEYBURN 2123

When changing farms do not overlook the vital matter of insurances. Every care should be taken to see that the buildings, live and dead stock on your new farm are adequately insured—it's best to talk it over with your Farmers' Union Secretary

•Assets exceed £9,000,000

FARMERS MUTUAL

NATIONAL FARMERS UNION
MUTUAL INSURANCE SOCIETY, LTD
Head Office: STRATFORD-ON-AVON
General Manager: G.C.D. Lindsay, F.C.I.I.

FUMITE

PURE LINDANE

Smoke Insecticide

Ideal for the control of mushroom fly, springtail, woodlice and common insect pests in mushroom houses. The FUMITE method is simple, labour-saving, non-tainting and costs only a few pence per 1,000 cu. ft.

LINDANE is the 99·8/99·9% pure, odourless gamma isomer of Benzene Hexachloride (BHC).

IT'S DEADLY EFFICIENT!

Obtainable in four pellet sizes from all Sundriesmen and Seedsmen.

Brit. Pat. Nos. 621732, 621894 and 651684, others pending.

WAECO Ltd. (FUMITE Division)
120/2 Victoria St., London, S.W.1
'Phone: Tate Gallery 9626
Factory:—High Post, Salisbury, Wilts.

● COMPOST FOR MUSHROOMS

WHEAT STRAW when treated with ADCO "M" will readily provide a substitute for horse manure for growing mushrooms

ADCO "M"

IMPROVES MANURE SUPPLIES

● LONG STRAW MANURE

Manure for mushroom culture such as that from racing stables is frequently in too long and dry a condition. This can be considerably improved by using ADCO "M" with better crops as a result.

Particulars & Prices from **ADCO LTD.** HARPENDEN, HERTS

for Quality and Service

ATLAS

Specialists in the Manufacture of Chip Baskets for the Mushroom Grower

THE MOST SUITABLE PACK FOR YOUR PRODUCE

THE ATLAS BASKET COMPANY LIMITED

HARPENDEN HERTS.

Telephone : Harpenden **3121** Telegrams : "Atlas, Harpenden"

SMALL ADVERTISEMENTS (3d. a word)

MUSHROOM GROWERS' supplies of all kinds, consult J. E. R. SIMONS LTD., Harlow, Essex. 'Phone Potter Street 65. Telegrams Simons Harlow. Sole distributors of MOUNT MUSHROOM SPAWN.

SALE. 3,000 TRAYS, 1′3″ × 3′1″ × 6″. Many with leather and wire handles. **2/6** each on site. G. P. BARR, "Bosworths," Slaugham, Haywards Heath, Sussex.

D.V.M. (15) POWDER. (ZINC ETHYLENE BIS-DITHIOCARBAMATE). THE ORIGINAL MATERIAL AVAILABLE FROM STOCK. 7-lb. bags 5/6 per lb.; 14-lb. bags 5/3d. lb.; J. E. R. SIMONS LTD., Harlow, Essex. 'Phone: Potter Street 65.

FOR SALE, TWO G.E.C. 3 K.W.H. FAN HEATERS, complete with thermostats. Little used, in perfect condition. **£10** each. Thermostats **20/-** each. Carriage Paid. WADSWORTH, Broadwath, Heads Nook, Carlisle, Cumberland.

GYPSUM direct from Gypsum Mines, 1 cwt. to 6 ton lots at competitive prices showing carriage charges separately. Delivery made from five centres. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone Potter Street 65.

PEAT. With the commencement of the new season we are now importing regular quantities of the famous **North German Peat** at 23/6d. per wooden slatted bale (no less than 10 bale lots). Dearer jute wrapped bales if required. Ex our Hackney Warehouse. R. C. DARLINGTON'S "386" PRODUCTS, Hastingwood, Harlow Essex. 'Phone: Potter Street 138.

RUBBER BANDS. 6 lb. lots, 8/6d. lb.; single lb., 9/0d. No. 18—2,300 to lb.; No. 32—1,175 to lb. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone Potter Street 65.

TONKIN CANES. Send for new season's Price List Tonkin Canes 4 ft. 6/8 lbs. to 24/26 lbs. Special price for 50-bale lots *ex* Hackney Warehouse. Also Split Chinese Flower Sticks 24 inch 97/- per 5,000 Bale. Cheapest house in the trade for Sundries. R. C. DARLINGTON, Hastingwood, Harlow, Essex.

SMOKE BOMBS, BHC DUSTS, DDT DUSTS. All best known brands Insecticides and Fungicides available. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone Potter Street 65.

PLASTIC HOSE, ½″, 6¾d. ft.; ¾″, 9½d. ft., 60 ft. lengths and multiples. Carriage Paid. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone: Potter Street 65.

ZINC ETHYLENE-BIS-DITHIOCARBAMATE—"386" PRODUCT. In 1 cwt., ½ cwt., 28 lb. Kegs Free. No less than 7 lb. all at 3/9 per lb. Carriage Forward. R. C. DARLINGTON, Hastingwood, Harlow, Essex.

CHIP BASKETS & PACKAGES at competitive prices. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone : Potter Street 65.

TRAYS. New in all designs. Used fish trays from 2/- each. Quotations by road or rail. J. E. R. SIMONS LTD., Harlow, Essex. Tel.: Potter Street 65. Telegrams : Simons, Harlow.

TRIGGER LANCES. To fit ½″, ⅝″, ¾″ & 1″ Hoses. Complete with Oval Rose, 37/6d. plus postage. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone : Potter Street 65.

PEAT. Specially selected for casing 27/6d. per single (2 cwt.) bale, carriage extra. Special quotation for 1, 2 or 4 tons delivered free. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone: Potter Street 65.

BARROWS. Coach built in wood, ash handles, Dunlop wheel specially constructed for hard usage—the barrow with a reputation—each £8 7s. 6d. J. E. R. SIMONS LTD., Harlow, Essex. 'Phone: Potter Street 65.

Published by the Mushroom Growers' Association, Yaxley, Peterborough, England
and printed by W. S. Maney & Son Ltd., Russell Street, Leeds 1